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Performance of Broadband Three-Component Stations and Far-Regional Arrays in the Monitoring of a Comprehensive Test Ban Treaty

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A key design consideration for the Primary and Auxiliary seismic networks of the International Monitoring System (IMS) for the Comprehensive Test Ban Treaty (CTBT) was that these networks be capable of locating events of magnitude 4 or larger with an uncertainty of less than 1,000 km^2, e.g., within a circle less than 18 km in radius. For low-yield explosions or evasively tested nuclear devices the resulting small magnitudes will preclude the recording of signals from IMS stations at teleseismic distances and will necessarily focus the analysis effort at distances of a few hundred to perhaps 2,000 km, where lateral heterogeneity in earth structure significantly complicates the problem. The purpose of our study is to compare the effectiveness of sparse broadband stations and regional seismic arrays for accomplishing the specified location accuracy, after the networks have been calibrated with a "ground truth" database of events with known locations. To evaluate the effectiveness of three-component stations we have used seismic events in both northern California, an ideal monitoring situation with its coverage by the Berkeley Digital Seismic Network (BDSN), and southern California, a more typical monitoring situation in which the BDSN stations are 200-900 km from the events. In addition, we evaluate the effectiveness of two seismic arrays, PDAR and TXAR, respectively in Wyoming and Texas, for monitoring the same regions at distances of 8° to 22°. "Ground truth" for events selected for this analysis was provided by the Northern and Southern California Earthquake Data Centers. We will present our results using only BDSN stations to locate events using standard location procedures, and will discuss what information or level of calibration is required to bring the event locations within the specified 18 km location goal. Results will also be presented for locating events in both northern and southern California with only the two regional arrays. Our work thus far has focused on the Ridgecrest earthquake sequence, which has a number of large M>5 events to be used for calibration, and a prolific aftershock sequence to test location performance to small magnitudes. Preliminary results indicate that with only 2-3 BDSN stations it is possible to obtain event locations of the desired accuracy to a magnitude ML of approximately 4.0, provided that adequate traveltime and azimuth adjustments have been obtained. The results for the two seismic arrays are similar, but with a threshold of ML about 3.8-3.9. We are trying to lower these thresholds through the use of dynamic waveform matching and other phase picking techniques.

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